

# Vertigo in Cerebrovascular Diseases

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## ABSTRACT

**Background:** Vertigo as a symptom of cerebrovascular disease is relatively uncommon. All types of cerebrovascular diseases namely ischemia, infarction, hemorrhage can produce vertigo. Since, cerebrovascular disease is an emergency prompt recognition and treatment is necessary to prevent neurologic deficit and death. Among cerebrovascular diseases vertebrobasilar territory strokes commonly present with vertigo. Since, the term vertigo is used nonspecifically by patients this may lead to delay in diagnosis of these strokes. This article reviews the epidemiology of vertigo in cerebrovascular diseases and the various stroke syndromes associated with vertigo.

**Summary:** Cerebrovascular diseases in the vertebrobasilar territory have vertigo, imbalance, dizziness in addition to other symptoms and signs. Posterior inferior cerebellar artery, anterior inferior cerebellar artery, superior cerebellar artery and basilar artery territory strokes can present with true vertigo. A high index of suspicion of stroke in patients with vertigo and risk factors for stroke is essential. Other vascular causes of vertigo are small cerebellar hemorrhage, vestibular cortex stroke, rotational vertebral artery syndrome, transverse/sigmoid sinus thrombosis and vestibular paroxysmia.

**Conclusion:** Cerebrovascular disorders are estimated to account for 3 to 4% of patients with vertigo or dizziness. Early detection and treatment is necessary to prevent disability and death in these cases of vascular vertigo.

**Keywords:** Vertigo, Cerebrovascular disease, Stroke, Vertebrobasilar territory.

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## INTRODUCTION

Dizziness/vertigo, difficulty walking, loss of balance/coordination are stroke symptoms in 50% of stroke presentations.<sup>1</sup> Vertigo/dizziness due to cerebrovascular disease (CVD) is usually associated with other neurological signs. Sometimes cerebellar and brain stem strokes may present with prominent vertigo and mimic acute vestibulopathy leading to a delay in diagnosis of stroke. Vertigo may overshadow other neurological features in particular vertebrobasilar territory stroke syndromes. Since CVD is a medical emergency, prompt treatment is crucial. Immediate recognition and early action is essential to prevent brain damage, disability and death.<sup>2</sup> CVD is the third most common cause of death in developed countries after coronary heart disease and cancer.<sup>3</sup> Globally, CVD is the second leading cause of death.<sup>4</sup> Of all CVDs cerebellar and

brain stem (medulla, pons) strokes are common causes of vascular vestibular syndromes. These CVDs may be confused with peripheral causes of vertigo. Misdiagnosis or delay in diagnosis is common in patients with vertebrobasilar territory CVD than with other types of CVD.<sup>5</sup> Vertigo, dizziness and imbalance are some of the symptoms of vertebrobasilar territory CVD. Vertigo is a specific type of dizziness with illusion of rotation of self or environment. Patients use the term dizziness and vertigo nonspecifically and interchangeably and physicians may not try to differentiate between these two. Moreover, whether the patient specifically describes vertigo or dizziness does not alter the likelihood of CVD. Although the proportion of cerebrovascular events in patients presenting with these symptoms is very low<sup>6</sup> these are serious and occasionally life-threatening events. Hence, the presence of these symptoms should lead to a thorough neurological examination and evaluation for possible CVD in patients with risk factor for stroke. Vertigo, due to CVD, is commonly central and sometimes a combination of central and peripheral as in anterior inferior cerebellar artery (AICA) infarction and rarely purely peripheral as in labyrinthine infarction or hemorrhage. Vertigo due to CVD, is associated with less vegetative symptoms and more severe imbalance and associated brain stem signs. A vascular origin should also be considered in cases of positional vertigo and isolated vertigo or dizziness when the presentation is not consistent with benign paroxysmal positional vertigo (BPPV), Meniere's disease and vestibular neuritis or if the etiology remains unclear.<sup>7</sup> A low threshold for neuroimaging especially magnetic resonance imaging (MRI) with diffusion images for detecting stroke and magnetic resonance angiography (MRA) for neurovascular anatomy is suggested in patients with risk factors for stroke presenting with vertigo of uncertain etiology.

## Epidemiology

Vertigo and dizziness are one of the most common complaints in medicine.<sup>8</sup> The most common causes of vertigo are peripheral vestibular disorders like BPPV, vestibular neuronitis and Meniere's syndrome.<sup>8</sup> BPPV is diagnosed more frequently since its underlying pathophysiology is described in details in the last decade with subsequent flood of information on the entity.<sup>9</sup> Vertigo may occur in 25% of patients with migraine. Thus, vestibular syndrome associated with migraine may be the most

common cause of central vertigo. The most important vestibular syndrome associated with migraine is migrainous vertigo (MV) or vestibular migraine. CVD is relatively uncommon but more serious cause of vertigo. CVD can lead to central and/or peripheral vertigo. In all patients presenting with vertigo peripheral vestibular disorders account for 75% and central disorders account for 25%.<sup>8</sup> In one study dizziness was attributed to cerebrovascular disorders in 6% of all patients presenting with dizziness. In a population-based study of dizziness symptoms (DS) namely dizziness, vertigo and imbalance in the emergency department, stroke or transient ischemic attack (TIA) was diagnosed in 3.2% of all patients with these symptoms. Only 0.7% of those with isolated DS had a stroke/TIA. The authors concluded that isolated dizziness, vertigo or imbalance strongly predicts a non-cerebrovascular cause. Among the DS, patients with imbalance were more likely to have stroke/TIA.<sup>6</sup> In another study of dizziness visits to US emergency departments, the 10 most frequent classes of diagnoses made were oto-vestibular (32.9%), cardiovascular (21.1%), respiratory (11.5%), neurologic (11.2%, including 4% cerebrovascular), metabolic (11.0%), injury/poisoning (10.6%), psychiatric (7.2%), digestive (7.0%), genitourinary (5.1%) and infectious (2.9%).<sup>10</sup> Thus, cerebrovascular disorders are estimated to account for up to 4% of patients with vertigo or dizziness in most epidemiological studies. Thus, 3 to 4% of patients with vertigo/DS are estimated to have CVDs as a cause of their symptoms.

### Central Vestibular Pathway

Vertigo due to CVD is commonly central vertigo. The vestibular nuclear complex in the pons and medulla, the various interconnecting pathways via the medial longitudinal fasciculus, oculomotor nuclei, supranuclear centers in the rostral midbrain, thalamic projections to the vestibular cortex, spinal cord, the vestibulocerebellum (flocculus and nodule) are the central parts of the vestibular system. The vertebrobasilar system supplies the inner ear, vestibular pathway and the cerebellum. The vestibular cortex is supplied by the middle cerebral artery.

### Vascular Anatomy

The vertebrobasilar system provides vascular supply to both the central and peripheral vestibular system. The posterior inferior cerebellar artery (PICA) is a branch of vertebral artery (VA). It supplies the vestibular nuclear complex in the dorsolateral medulla via small branches. More frequently the dorsolateral medulla receives direct branches from the vertebral artery. The PICA divides into medial and lateral

branches. The medial branch of the PICA (mPICA) supplies the dorsomedial area of the caudal cerebellum and the inferior vermis (nodulus and uvula). The lateral branch of the PICA supplies the inferior and posterior surface of the cerebellar hemispheres.<sup>11</sup> The perforator branches of the basilar artery supply the other central vestibular structures in the pons. The AICA, a branch of the basilar artery, supplies both the peripheral vestibular system and the central vestibulocerebellar structures. It supplies the ventrolateral cerebellum, flocculus, middle cerebellar peduncle and the lateral tegmentum of the lower two-thirds of the pons (housing the cochlear and vestibular nuclei). The internal auditory artery (IAA); (syn. labyrinthine artery) a branch of the AICA divides into anterior vestibular artery and common cochlear artery. The anterior vestibular artery supplies the vestibular nerve, utricle, ampullae of the lateral and anterior semicircular canals. The common cochlear artery via the vestibulocochlear artery supplies cochlea, ampulla of the posterior semicircular canal and inferior part of the saccule.<sup>12</sup> Thus, the AICA supplies the inner ear (via the labyrinthine artery), hence, infarcts in this territory can lead to isolated peripheral vertigo. The superior cerebellar artery (SCA) supplies the superior half of the cerebellar hemisphere and vermis as well as the dentate nucleus and upper part of pontine tegmentum. The SCA divides into lateral and medial branches. The medial SCA divides into vermian, paravermian and hemispheric arteries. The vermian branches supply the rostral vermis and the hemispheric branches supply the dorsomedial surface of the rostral cerebellar hemisphere. The vermis is related to gait and postural control while the cerebellar hemispheres are responsible for limb control.<sup>11,13</sup> The vestibulocerebellum (flocculonodular lobe) is the center for vestibular control. Hence, vermian and flocculonodular lobe infarction cause vertigo and cerebellar hemisphere infarcts cause limb ataxia.

### Cerebrovascular Diseases/Stroke Syndromes associated with Vertigo

#### *Ischemic Stroke*

Ischemic strokes in the territory of PICA, AICA and SCA present with vertigo with or without other symptoms of brain stem dysfunction (Table 1 for all cerebrovascular causes of vertigo). Sometimes vertigo may be the only symptom of these stroke syndromes.

#### *PICA Territory Infarcts*

The PICA supplies the dorsolateral medulla which includes the vestibular nucleus complex, posterior inferior cerebellum, inferior cerebellar peduncle, vermis including nodulus and cerebellar tonsil as discussed earlier. Ischemia

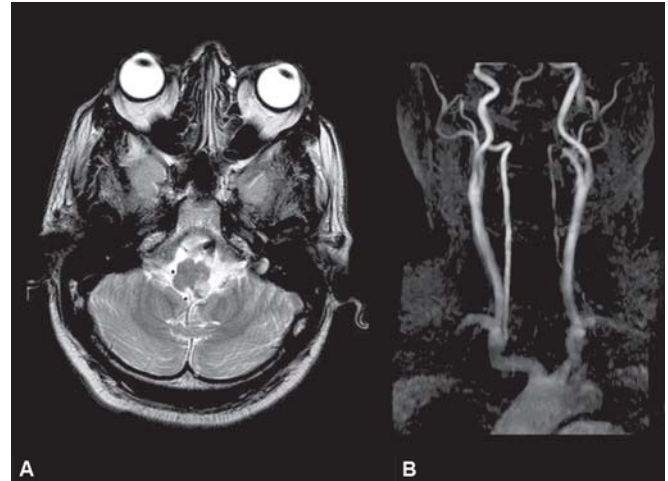
or infarcts in any of these regions can produce vertigo. The classic PICA stroke is the lateral medullary syndrome (LMS) or Wallenberg's syndrome with a constellation of features. There are several partial PICA syndromes causing vertigo without all the features of LMS. Among the cerebellar infarcts PICA territory infarcts are the commonest.<sup>13</sup> The mechanism of PICA infarcts is embolism or atherothrombosis of the vertebrobasilar system and vertebral artery dissection.<sup>14</sup>

*Lateral medullary syndrome or Wallenberg's syndrome:*

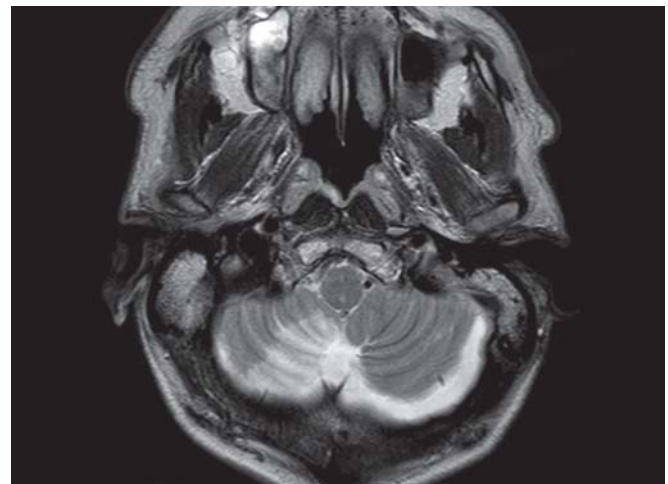
This syndrome results from occlusion of one of the penetrating branches of PICA or more commonly the vertebral artery. Thrombosis of the vertebral artery or vertebral artery dissection can cause this syndrome. Neck pain and frontal headache is a prominent symptom in these patients. The various DS associated with LMS are true vertigo, imbalance, dizziness, swaying to one side, feeling sea sick or illusion of tilting to one side and ipsipulsion. The neuroanatomic basis for these symptoms is vestibular nuclei, inferior cerebellar peduncle and olivocerebellar pathway. The ocular tilt reaction (OTR) in LMS is due to ischemia of the medial vestibular nucleus and lesion of the vertical (posterior) semicircular canal pathway. The OTR comprises of ipsiversive head (and body) tilt, vertical misalignment of the visual axes (skew deviation with ipsilateral eye being lower) and excyclotropia. Nystagmus is typically of the central type typically horizontal and rotatory in the primary position, of varying amplitude, multidirectional or direction changing (left beating on left gaze and right beating on right gaze), down beating, upbeating or torsional. Hypermetric saccades toward the affected side and hypometric saccades toward the opposite side are common.

The other features of LMS are facial numbness or pain due to involvement of spinal nucleus and tract of trigeminal nerve. Diminished pinprick and temperature sensation in the contralateral limbs and body is due to involvement of spinothalamic tract. Ipsilateral limb ataxia or gait ataxia is due to involvement of the inferior cerebellar peduncle or the inferior surface of the cerebellum. Involvement of the descending sympathetic tract leads to Horner's syndrome. Dysphagia and hoarseness of voice are due to involvement of the vagal nuclei. Sometimes ipsilateral facial palsy is seen due to involvement of the caudal part of the facial nucleus (Table 2 for neurological features of stroke syndromes associated with vertigo). A typical MRI of a patient with LMS is shown in Figures 1A and B.

*Medial PICA syndrome:* Is a partial PICA territory infarct. It presents as isolated vertigo which is often misdiagnosed as peripheral vertigo. Vertigo with ipsilateral axial



**Figs 1A and B:** MRI finding in a patient with LMS. (A) T2-weighted MRI scan of the brain showing hyperintense foci in the left dorsolateral medulla, (B) MRA showing narrowing of the left vertebral artery suggestive of stenosis. LMS: Lateral medullary syndrome



**Fig. 2:** MRI finding in a patient with mPICA syndrome. Hyperintense signal in the right medial caudal cerebellum suggestive of infarct

lateropulsion and unsteadiness with vertigo is more often the presenting symptom. Isolated vertigo is due to infarction in the nodulus and is referred to as pseudolabyrinthitis or pseudo acute peripheral vestibulopathy.<sup>15</sup> There may be direction changing nystagmus on gaze to each side or after changing head posture with normal vestibular responses and negative head impulse test. Since, mPICA infarction closely mimics labyrinthitis, MRI is recommended in patients over 50 years with vascular risk factors presenting with acute onset vertigo.<sup>16</sup> The mPICA infarcts appear as a triangular area in the dorsomedial cerebellum with a broad dorsal base and ventral top directed toward the fourth ventricle.<sup>15</sup> A typical MRI of a patient with mPICA infarct is shown in Figure 2.

*Isolated nodular infarction:* These present with vertigo mimicking peripheral vestibulopathy. There may be ipsilesional spontaneous nystagmus and falling to the

**Table 1:** Stroke syndromes associated with vertigo

1. Vertebrobasilar territory infarcts
  - Posterior inferior cerebellar artery infarct
  - Medial branch of posterior inferior cerebellar artery infarct
  - Isolated nodular infarct
  - Anterior inferior cerebellar artery infarct
  - Superior cerebellar artery infarct
  - Internal auditory artery infarct
2. Vertebrobasilar insufficiency/transient ischemic attacks
3. Rotational vertebral artery syndrome
4. Carotid territory infarcts
  - Middle cerebral artery infarct (insular stroke)
5. Hemorrhagic stroke
  - Cerebellar hemorrhage (small)
  - Pontine hemorrhage (cavernomas)
  - Medullary hemorrhage (rare)
  - Intralabyrinthine hemorrhage
6. Cerebral venous sinus thrombosis
  - Transverse/sigmoid sinus thrombosis

**Table 2:** Neurological features of stroke syndromes associated with vertigo

	PICA LMS	AICA	SCA	Brainstem cerebellar hemorrhage	ILH	Ins.	mPICA, nodular infarction	LA infarction	T/SST	BT	LPICA without medullary infarct	mSCA	ISCA
Vertigo	++	++	++	++	++	++	++	++	++	++	++	++	++
Headache	++	-	+	++	-	-	+	-	++	++	-	+	+
Neck pain*	++	-	-	-	-	-	++	-	-	-	++	-	-
Drowsiness	-	-	±	++	-	-	-	-	+	++	-	-	-
Nystagmus	++	-	++	++	++	-	++	++	-	++	-	++	++
Ipsipulsion	++	-	-	++	-	-	++	-	-	-	-	-	-
Contrapulsion	-	-	++	++	-	-	-	-	-	-	-	++	++
Skew deviation	++	++	-	+	-	-	-	-	-	-	-	-	-
Gait/ipsilateral limb ataxia	++	++	++	+	-	-	++	-	+	++	++	++	++
Tinnitus/hearing loss	-	++	-	-	++	-	-	++	-	-	-	-	-
Facial palsy	++	++	-	++	-	-	-	-	-	++	-	-	-
Facial pain	++	++	+	-	-	-	-	-	-	-	-	-	-
Contralateral hemianesthesia	++	++	+	-	-	-	-	-	-	-	-	-	-
Horner's syndrome	++	++	+	-	-	-	-	-	-	-	-	-	-
Dysphagia	++	-	-	+	-	-	-	-	-	++	-	-	-
Impaired vibration/position	-	-	+	-	-	-	-	-	-	-	-	-	-
Dysarthria	++	++	+	+	-	+	-	-	-	++	-	++	++
Hemiparesis	-	+	-	-	-	+	-	-	-	++	-	-	-

++: Prominent; +: Present; -: Absent; \*: In presence of vertebral artery dissection; PICA: Posterior inferior cerebellar artery; LMS: Lateral medullary syndrome; AICA: Anterior inferior cerebellar artery; SCA: Superior cerebellar artery; mPICA: Medial PICA; LPICA: Lateral PICA; LA infarction: Labyrinthine artery infarction; T/SST: Transverse/sigmoid sinus thrombosis; mSCA: Medial SCA; ISCA: Lateral SCA; BT: Basilar artery thrombosis; Ins: Insular lesions; ILH: Intralabyrinthine hemorrhage

contralesional side which resembles damage to contralesional labyrinth.<sup>17</sup> However, severe imbalance and a negative head impulse test are important clinical discriminants between nodular infarcts and peripheral vestibular dysfunction.<sup>18</sup> A negative head impulse test during the acute phase of vestibulopathy accompanying spontaneous nystagmus strongly suggests central lesions.<sup>18</sup> Isolated nodular infarctions lead to disruption of nodular inhibition on the vestibular secondary neurons and subsequent lateropulsion.

*PICA territory infarct sparing the medulla:* These mainly present with vertigo, ataxia and ipsilateral axial

lateropulsion. There is falling toward the side of cerebellar infarction. The other features related to medullary involvement are absent.<sup>14</sup>

### AICA Territory Infarcts

The AICA supplies both the peripheral and central vestibular structures. AICA consistently supplies the lateral pontine tegmentum and middle cerebellar peduncle which have the vestibular, cochlear nuclei and the cortico-ponto-cerebellar fibers respectively. AICA infarcts typically present as inferior lateral pontine syndrome. These infarcts are usually never pure cerebellar infarcts unlike SCA or PICA territory infarcts.



**Fig. 3:** MRI finding in a patient with basilar thrombosis and midbrain infarcts. Multiple hyperintense signals in the midbrain suggestive of infarcts

### *Labyrinthine Infarcts*

The vestibulocochlear nerve, cochlea and the vestibular labyrinth are susceptible to ischemia since they are supplied by the internal auditory artery (IAA) which is an end artery. The vestibular labyrinth is selectively susceptible to ischemia in the vertebrobasilar territory. Labyrinthine ischemia can present as isolated episodes of abrupt onset vertigo lasting for minutes.<sup>19</sup> Occlusion of the IAA can cause sudden profound deafness and vertigo due to inner ear and labyrinthine infarction without brain stem or cerebellar signs. This presentation is easily confused as being an acute peripheral vestibular syndrome. Isolated auditory disturbance is also well described as a prodrome of AICA infarction.<sup>20</sup> It is important to keep in mind that sudden onset vertigo or deafness can be harbinger of AICA infarct or a basilar thrombosis as reported in several case reports.<sup>21,22</sup> The initial MRI may be normal in these cases of ischemia (not infarction) in the territory of AICA. Thus vertebrobasilar territory stroke should be considered in patients with vascular risk factors presenting with isolated vertigo even in the absence of brain stem or cerebellar signs.<sup>16,19,23</sup>

### *AICA Syndrome, Inferior Lateral Pontine Syndrome*

The lateral mid and inferior pons, anterolateral part of the cerebellum, middle cerebellar peduncle, flocculus, and the anterior part of the cerebellar lobules, except the anterior lobule is supplied by the AICA. The classic AICA syndrome is associated with vertigo, hearing loss, facial weakness, hypoalgesia, nystagmus, ipsilateral Horner's syndrome contralateral trunk and extremity hypalgesia and thermoanesthesia and ipsilateral ataxia.<sup>20,24,25</sup> The clinical manifestations of AICA syndrome can be confused with the lateral medullary syndrome because of several common features. However, deafness due to involvement of VIII

cranial nerve/nuclei, massive facial palsy due to VII cranial nerve/nuclei, lateral gaze palsy, and multimodal sensory impairment of the face are the differentiating features (Table 2 for neurological features of AICA infarction).<sup>26</sup>

### *SCA Territory Infarcts*

Of the various cerebellar stroke syndromes SCA territory strokes rarely cause vertigo.<sup>27</sup> SCA territory infarcts are usually cardioembolic.<sup>14</sup> The flocculonodular lobe has the vestibulocerebellar connections and is supplied by the AICA and the PICA. The lateral SCA territory infarction presents with ipsilateral limb ataxia, gait and truncal ataxia and dizziness. The medial SCA infarction has prominent ipsilateral axial lateropulsion. The classic SCA infarct consists of dysarthria, ipsilateral ataxia, intention tremor, Horner's syndrome, contralateral loss of pain and temperature. Ipsilateral abnormal limb movements, few weeks later palatal myoclonus may occur in some cases with dentate nucleus involvement.

### **Vertebrobasilar Ischemia Insufficiency, Transient Ischemic Attacks**

Hypoperfusion in the territory of vertebral, basilar, PICA, AICA, SCA can cause ischemia of the cerebellum or brain stem. These episodes can present as episodic vertigo, dizziness, imbalance with or without symptoms of brainstem dysfunction. Vertigo due to vertebrobasilar insufficiency (VBI) typically is associated with diplopia, dysarthria, ataxia, visual defects. VBI can also present as isolated vertigo and is easily confused with peripheral vertigo. The duration of symptoms of VBI is usually minutes. Vertigo may precede other symptoms of VBI or infarction by months. Isolated episodes of vertigo can be the sole manifestation of VBI.<sup>19,28</sup> Posterior circulation TIAs presenting as pure vertigo may be an heralding symptom of basilar thrombosis. Labyrinthine ischemia is the most likely cause of vertigo in these cases. Prompt treatment with anticoagulation and antiplatelet medications improve short-term prognosis in middle and distal segment basilar artery stenosis.<sup>29</sup> Isolated episodic vertigo lasting for weeks can also be a symptom of VBI.<sup>30</sup> Patients with isolated vertigo of vascular origin are usually older, have high body mass index, metabolic derangement, and more stroke risk factors.<sup>31</sup> Patients with three or more risk factors for stroke having isolated vertigo or dizziness are more likely to have VBI as the cause of their vertigo. Hence, in patients complaining of isolated vertigo or dizziness of unexplained etiology and having at least three thrombotic stroke risk factors, vertebrobasilar radiological evaluation (MRA) is recommended.<sup>16</sup> Vertigo, nausea and headache are the most

common prodromal symptoms occurring during the weeks before the basilar or vertebral artery stroke.<sup>32</sup> Vertigo associated with headache, nausea and vomiting are prominent early but nonspecific complaints of basilar artery occlusion.<sup>33</sup> An MRI of a patient presenting with prodrome of vertigo, ataxia, headache and hemiparesis progressing to brain stem stroke is shown in Figure 3.

### Hemorrhagic Stroke

Hemorrhage in the brain stem and cerebellum can produce acute vertigo, nausea, vomiting and headache. Rapid progression to coma and death is frequent in massive cerebellar hemorrhage. Small cerebellar hemorrhage, especially around the vermis, sometimes causes isolated dizziness symptoms with positional nystagmus similar to that of BPPV.<sup>9,34,35</sup> It is difficult to differentiate central positional vertigo from benign positional vertigo on clinical grounds alone. One should not hesitate to order neuroimaging in these cases especially in the emergency department setting.<sup>9</sup> Axial lateropulsion ipsilateral to lesion is common in cerebellar hemorrhage. Small strokes in these regions, cavernomas with microhemorrhages can lead to vertigo and mimic labyrinthine lesions.<sup>36</sup>

### Labyrinthine Hemorrhage

Patients with bleeding diathesis, sickle cell disease, anti-coagulation therapy can get spontaneous intralabyrinthine hemorrhage.<sup>37,38</sup> This presents as sudden onset of unilateral deafness and severe vertigo. Dedicated MRI of the inner ear is essential for the diagnosis of intralabyrinthine hemorrhage.

### Cerebral Venous Sinus Thrombosis

Unilateral peripheral vestibulopathy as a presenting symptom of cerebral venous sinus thrombosis has rarely been reported.<sup>39</sup> Patients with cerebellar venous sinus thrombosis present with dizziness, nausea, imbalance with other cerebellar signs like limb ataxia.<sup>40</sup> Cerebellar venous infarction is rare because of abundant collaterals.<sup>41</sup> Cerebral venous sinus thrombosis of the transverse and/or sigmoid sinuses can present as isolated peripheral vestibulopathy without nystagmus and brain stem or cerebellar signs. More commonly vertigo and vestibulocochlear neuropathy is associated with symptoms of additional cranial neuropathies and headache.<sup>42</sup>

### Rotational Vertebral Artery Syndrome

In the rotational vertebral artery syndrome recurrent attacks of vertigo, ataxia are precipitated by head rotation leading

to compression of vertebral artery in elderly patients with atheromas and cervical spondylosis.<sup>43</sup> Isolated positional vertigo or dizziness can be a symptom of vertebral artery stenosis. Transient ischemic attacks of the semicircular canals or vestibular nucleus during rotation and extension of neck compresses the contralateral vertebral artery in patients with bilateral vertebral artery stenosis. Hence, patients complaining of isolated positional vertigo or dizziness of unexplained etiology could be having rotational vertebral artery syndrome. These patients having at least three thrombotic stroke risk factors should undergo evaluation for vertebral artery stenosis.<sup>16</sup>

### Vestibular Paroxysmia

Vestibular paroxysmia results from cross compression of the vestibular nerve by a vascular loop usually the basilar, vertebral, anterior inferior cerebellar or the posterior-inferior cerebellar arteries. There are brief attacks of vertigo, tinnitus, vestibular and auditory deficits termed disabling positional vertigo by Jannetta.<sup>44,45</sup>

### Vestibular Cortex CVD

The exact location of the vestibular cortex in humans has not yet been established.<sup>46</sup> The parieto-insular cortex is postulated to be the vestibular cortex with bilateral representation and right hemispheric dominance. Small hemorrhage or embolic stroke in this territory of the middle cerebral artery and the adjacent superior temporal, long insular, transverse temporal and medial temporal gyri can lead to rotatory vertigo. Contralesional lateropulsion, unsteadiness, slurring of speech, absence of nystagmus and other brain stem signs are the other features of lesions in these location.<sup>47,48</sup> A patient with recurrent episodes of vertigo and imbalance following a small lesion in the anterior insula has been reported.<sup>46</sup> Supratentorial lesions accompanied by dizziness or vertigo are mostly localized in temporal or central areas.<sup>49</sup>

### CONCLUSION

CVD is an important and serious cause of vertigo. CVD should be high in the list of differential diagnosis of vertigo in elderly with risk factors for atherothrombosis (diabetes, hypertension, hypercholesterolemia, obesity, metabolic syndrome, thrombophilia and smoking) or embolism (cardiac arrhythmia, valvular heart disease, septal defects). Vertigo, imbalance with headache may be the only symptom of partial lateral medullary syndrome. Labyrinthine infarct and hemorrhage can mimic peripheral vestibulopathy. Partial AICA infarcts can present with isolated vertigo. SCA

infarct rarely causes vertigo and ipsilateral ataxia. VBI may present with isolated vertigo. Vertigo may precede other symptoms of VBI or infarction by months. Vertebrobasilar TIAs presenting as pure vertigo may herald basilar thrombosis. Vertigo with central nystagmus, ataxia, dysarthria, dysphagia, diplopia, facial and limb weakness is most likely due to brain stem stroke. Small hemorrhages in cerebellum, brain stem may mimic labyrinthine disease. Transverse/sigmoid sinus thrombosis may present with vertigo, vestibulocochlear neuropathy and headache. Rotational vertebral artery syndrome can cause positional vertigo, imbalance on neck rotation and extension in the setting of cervical spondylosis and vertebral artery stenosis. Parieto-insular, temporal or central strokes in the middle cerebral artery territory can present with vertigo, unsteadiness and slurred speech. Since, computed tomography does not image the brain stem and cerebellum well an MRI with diffusion images for brain stem, cerebellar infarction and MRA for vertebrobasilar thrombosis, dissection is recommended in patients with risk factor for CVD. Urgent therapy is life saving and will prevent deficit and disability.

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